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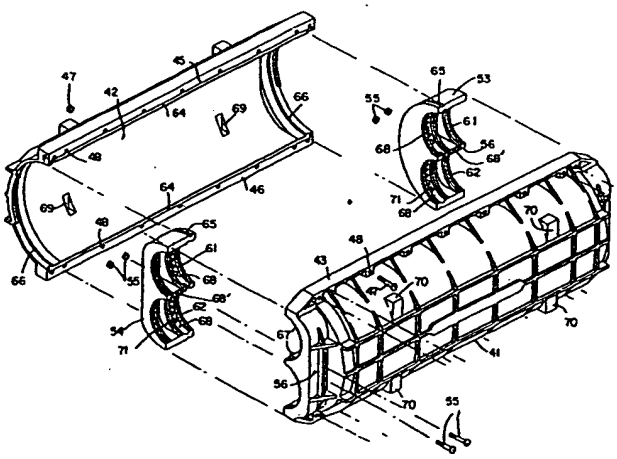

(57) Abstract

The splice closure (30) includes a tubular protective case (31) comprising front and back covers (42, 41). The left and right ends of the back cover (41) are configured to form integrally therewith left rear and right rear half end seals (51, 52), which are adapted to mate with separately formed, left front and right front half end seals (53, 54). Left front and right front half end seals (53, 54) are formed to fit inside the left and right ends of the front cover (42). The separately formed, left front half end seal (53) is secured to the integrally formed, left rear half end seal (51), with a first set of cables (33) clamped between the mating surfaces thereof. Likewise, the separately formed, right front half end seal (54) is secured to the integrally formed, right rear half end seal (52), with a second set of cables (34, 35) clamped between the mating surfaces thereof. The two sets of cables (33–35) are spliced together (36) and the front cover (42) is bolted in place over the back over/spliced cables/end seal assembly to form the protective case (31). Before the two covers (42, 41) are bolted together, a sealant is disposed between the mating surfaces to prevent dust from entering the protective case (31).

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SPLICE CLOSURE

Background and Summary of the Invention

The present invention generally relates to a splice closure for protecting spliced communication cables. More particularly, this invention relates to a reenterable and reusable splice closure.

The telecommunications industry utilizes cables comprising numerous individual conductors, such as copper wire or fiberoptic conductors. In the laying of the communications cables, it is often necessary to splice sections of these cables. Also, the communication cables sometimes get damaged during their use due to a variety of factors, such as high wind, storm, snow, etc. When they are damaged, it is necessary to splice together the damaged sections of the cable. Typically, a splice closure is positioned around the splice to protect the exposed conductors from the elements, and also to protect the splice from the lateral and vertical forces.

A reference may be made to U.S. Patent No. 3,337,681 for a description of a prior art splice closure. Such splice closure includes a protective tubular case comprising two semicircular half tubular members, with circular end seals disposed inside the tubular case at each end. Each of the end seals, in turn, comprises two semicircular half end seals, and is configured to form a longitudinal cavity through which cables enter the protective case to form a splice. A liner made from a flexible material, such as Neoprene, is bonded to the inside surface of the tubular case. The liner seals the joints between the two half tubular members and between the end seals and the tubular case.

The present invention relates to an improved splice closure with fewer parts, relatively inexpensive to manufacture, easy to assemble and disassemble - especially in the field and capable of being sealed, unsealed and resealed.

According to the present invention, the splice closure includes a tubular protective case comprising back and front covers. The left and right ends of the back cover are configured to form integrally therewith left rear and right rear half end seals, which are adapted to mate with separately formed, left front and right front half end seals. The left front and right front half end seals are formed to fit inside the left and right ends of the front cover. The separately formed, left front half end seal is secured

to the integrally formed, left rear half end seal, with a first set of cables clamped between the mating surfaces thereof. Likewise, the separately formed, right front half end seal is secured to the integrally formed, right rear half end seal, with a second set of cables clamped between the mating surfaces thereof. The two sets of cables are spliced together and the front cover is bolted in place over the back cover/spliced cables/end seal assembly to form the protective case. Before the two covers are bolted together, a sealant is disposed between the mating surfaces of the front and back covers and between the outer surfaces of the left front and right front half end seals and the interior surfaces of the front cover to prevent extraneous material, such as water, dust, debris, snow, etc., from entering the protective case.

In the preferred embodiments, the mating surfaces of the two covers are formed to include a longitudinal sealing groove, and the outer peripheral surfaces of the separately formed, left front and right front half end seals and the inner peripheral surfaces of the front cover are formed to include a circumferential sealing groove. A strip of composite sealing material, comprising a substantially non-tacky, resilient and yieldable sealant attached to an adhesive substrate, is disposed in the longitudinal sealing grooves in the back cover and in the outer circumferential sealing grooves in the left front and right front half end seals to seal the respective joints. The composite sealing material is disposed in the longitudinal and circumferential sealing grooves with the adhesive substrate contacting and adhering to the sealing grooves and with the non-tacky sealant facing away from the sealing grooves. This facilitates removal of the front cover from the back cover/spliced cables/end seal assembly for repairs or inspection without damaging the sealant. Upon completion of the work, the front cover is merely re-bolted in place.

In further preferred embodiments, the longitudinal grooves in the two covers have a wave-form cross section to compensate for the variation in pressure that occurs when the two covers are bolted together.

In still further preferred embodiments, the end sections of the cables are first wrapped with a narrow strip (about ½ inch (about 1.3 cm) wide) of soft and sticky sealing material (such as mastic sealant), then wrapped with a sizing tape (about 4 inches (about 10.2 cm) wide) and then finally with a strip of composite sealing material (about 1 inch (about 2.6 cm) wide) (with the adhesive substrate contacting and

adhering to the sizing tape) before the cables are clamped between the respective half end seals.

Additional features and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of the preferred embodiments exemplifying the best mode of carrying out the invention as presently perceived.

Brief Description of the Drawings

The detailed description particularly refers to the accompanying figures in which:

Fig. 1 is a front view of the completely assembled splice closure of the present invention, with the cables and the front cover installed;

Fig. 2 is a front view of the Fig. 1 splice closure, with the cables installed and spliced, but without the separately formed, left front and right front half end seals and without the front cover;

Fig. 3 is a left, front and top exploded perspective view of the splice closure of Figs. 1, 2, showing the back cover with integrally formed, left rear and right rear half end seals, separately formed left front and right front half end seals and the front cover;

Fig. 4 is an exploded perspective view of the splice closure, similar to Fig. 3, but taken from the back, depicting the internal features of the separately formed, left front and right front half end seals and the front cover;

Fig. 5 is a front view of the back cover having a bathtub-like configuration;

Fig. 6 is a cross-sectional view of the back cover taken along the line 6-6 in Fig. 5, with a portion broken away to show the details of the longitudinal grooves arranged in the top and bottom flanges of the back cover;

Fig. 7 is an enlarged view of a section of a longitudinal groove showing its wave-form configuration relative to the apertures for the nut and bolt combinations used to secure the front and back covers;

Fig. 8 is a cross-sectional view of the back cover taken along the line 8-8 in Fig. 5, and showing the integrally formed, left rear half end seal having two semicircular longitudinal cavities with serrated interior surfaces;

Fig. 9 is a cross-sectional view of the back cover taken along the line 9-9 in Fig. 5, and showing the integrally formed, right rear half end seal having two semicircular longitudinal cavities and a plurality of coring holes therein;

Fig. 10 is a back view of the front cover;

Figs. 11, 12 are cross-sectional views of the front cover respectively taken along the lines 11-11, 12-12 in Fig. 10;

Fig. 13 is a back view of the left front half end seal;

Figs. 14 is a cross-sectional view of the left front half end seal (similar to Fig. 8) taken along the line 14-14 in Fig. 13, and showing the serrated interior surfaces of the two longitudinal semicircular cavities formed therein; and

Figs. 15 is a cross-sectional view of the left front half end seal (similar to Fig. 9) taken along the line 15-15 in Fig. 13, and showing the inner and outer circumferential sealing grooves and further showing a plurality of coring holes formed therein.

Detailed Description of the Drawings

As illustrated in Figs. 1-2, the splice closure 30, in accordance with the present invention, comprises a tubular protective case 31 having a longitudinal axis 32. A cable 33 enters the left end of the protective case 31 through a generally circular, left end seal and a pair of cables 34, 35 enter the right end of the protective case through a generally circular, right end seal to form a splice 36. A blank plug 37 is used to close off one of the two longitudinal cable entrances in the left end seal as shown. Although a typical splice comprises one cable branching into two cables as shown, a splice may also comprise of any one of the following configurations: one cable in and one cable out, two cables in and two cables out and two cables in.

The end sections of the cables 33-35 are wrapped with a narrow strip of soft and sticky sealant, then with a strip of sizing tape and then finally with a strip of composite sealant to make the cables fit tightly in the longitudinal cable entrances in the respective end seals without any gaps. In Figs. 1, 2, the numeral 38 designates the

wrapped portions of the cables 33-35, and numeral 38' designates the outermost wrap of the composite sealant.

As shown in Fig. 3, the tubular protective case 31 comprises a back cover 41 and a front cover 42. The back and front covers 41, 42 have a generally semicircular transverse cross section. The top and bottom edges of the back and front covers 41, 42 are configured to form top and bottom longitudinal flanges 43, 44 and 45, 46, respectively. A plurality of nut and bolt combinations 47 is positioned in the apertures 48 in the adjacent pairs of top and bottom flanges 43, 45 and 44, 46 to secure the front cover 42 to the back cover 41.

The left and right ends of the back cover 41 are formed to define integrally therewith left rear and right rear half end seals 51, 52. The back cover 41 and the two integrally formed, left rear and right rear half end seals 51, 52 together form a hollow bathtub-like member. The integrally formed, left rear and right rear half end seals 51, 52 are adapted to mate with the separately formed, left front and right front half end seals 53, 54 (also referred to as clamping seals), respectively. The left front and right front half end seals 53, 54 are dimensioned and configured to fit inside the left and right ends of the front cover 42, respectively.

A set of nut and bolt combinations 55 (shown in Fig. 1) are positioned in the apertures 56 in the adjacent pair of left front and left rear half end seals 53, 51 to clamp the separately formed, left front half end seal to the integrally formed, left rear half end seal to form the generally circular, left end seal. Similarly, another set of nut and bolt combinations 55 (shown in Fig. 4) is positioned in the apertures 56 in the adjacent pair of right front and right rear half end seals 54, 52 to clamp the separately formed, right front half end seal to the integrally formed, right rear half end seal to form the generally circular, right end seal.

As shown in Figs. 3 and 4, each of the four half end seals 51-54 is provided with two longitudinal cavities 61, 62 of a generally semicircular configuration. When the left front half end seal 53 is bolted to the left rear half end seal 51, the corresponding semicircular cavities 61, 62 form two generally circular longitudinal cable entrances. Similarly, when the right front half end seal 54 is bolted to the right rear half end seal 52, the corresponding semicircular cavities 61, 62 form two generally circular longitudinal cable entrances. The inside surfaces of the

semicircular longitudinal cavities 61, 62 are jagged or serrated as shown in Figs. 3, 4, 8 and 14. When the splice closure 30 is assembled, the jagged surfaces of the end seals 51-54 are embedded in the composite sealant and the sizing tape wrapped around the cables 33-35 to form a tight seal between the cables and the splice closure 30. The jagged surfaces of the end seals 51-54 also serve to prevent axial slippage between the cables and the splice closure 30.

Although the end seals 51-54 are each provided with two cable entrances 61, 62 at each end in the particular embodiment shown and described, it is contemplated that each of the end seals may instead be provided with three (or more) cable entrances depending on the application.

As shown in Figs. 3, 5 and 6, the top and bottom flanges 43, 44 of the back cover 41 are provided with a pair of longitudinal sealing grooves 63 alongside the apertures 48 therein. Likewise, as shown in Figs. 4, 10 and 11, the top and bottom flanges 45, 46 of the front cover 42 are equipped with a pair of longitudinal sealing grooves 64 alongside the apertures 48 therein.

As shown in Figs. 3, 4, 13 and 15, the outer peripheral surfaces of the separately formed, left front and right front half end seals 53, 54 are configured to form outer circumferential sealing grooves 65. The interior surfaces of the front cover 42, on the other hand, are formed to include corresponding inner circumferential grooves 66, as can be seen from Figs. 4, 10 and 11.

As shown in Figs. 3, 5, 6 and 9, the inner surfaces of each of the semicircular longitudinal cavities 61, 62 in the integrally formed, left rear and right rear half end seals 51, 52 are configured to include inner circumferential sealing grooves 67. Similarly, as shown in Figs. 4, 13 and 15, the inner surfaces of each of the semicircular longitudinal cavities 61, 62 in the separately formed, left front and right front half end seals 53, 54 are formed to include inner circumferential sealing grooves 68.

In operation, to splice the cables 33-35, the respective end sections of the entering cables are wrapped with a narrow (about ½ inch (about 1.3 cm) wide) strip of soft and sticky sealing material, then wrapped with a sizing tape (about 4 inches (about 10.2 cm) wide) and finally wrapped with a further layer of composite sealing material (about 1 inch (about 2.6 cm) wide) (with the adhesive substrate facing the sizing tape). The layers 38 of the composite sealing material and the sizing tape

wrapped around the cables 33-35 form a cross section just barely larger than the cross section of the generally circular, longitudinal cable entrances in the left and right end seals. A simple (throw-away) cardboard gauge may be supplied to the field technician to determine when a sufficient number of turns of the sealing material and the sizing tape have been applied to the cables.

The innermost wrap of soft and sticky sealing material serves to close any gap between the cables 33-35 and the innermost layer of the sizing tape. The soft and sticky sealing material may be a suitable mastic sealant.

Later removal of the sticky mastic material from the cables 33-35 is not important. As explained later, only the front cover 42 is removed for repairs or inspection of the splice 36, and the back cover/spliced cables/end seal assembly is left undisturbed during such work.

When assembled, the outermost wrap of composite sealing material is pressed into the sealing grooves 67, 68 in the end seals to form a tight seal between the sizing tape and the interior surfaces of the cable entrances in the end seals. The composite sealing material may be in the form of a substantially non-adhesive, resilient and yieldable sealant non-releasably secured to an adhesive substrate. The sealant may be selected from a group consisting of EPDM, halogenated butyl, butyl, or some combination thereof, hydrated aluminum, resins, paraffinic oil, halogenated plasticizer, polybutene and polyisobutylene. The adhesive may be selected from a group consisting of butyl, halogenated butyl, or some combination thereof, hydrated aluminum, resinic polybutenes, halogenated paraffin and polyisobutylene. A reference may be made to the U.S. Patent Application Serial No. 08/783,693, filed on January 15, 1997, for a more detailed description of the composite sealing material of this type.

The sizing tape may be a weather-proof and solvent proof hard tape (such as Neoprene, EPDM, etc.), having on one side thereof spaced-apart narrow strips of sticky substance (to hold it in place during assembly) and having on the other side thereof a coating of high friction material (to prevent the successive turns of the sizing tape from sliding over each other or slide over the cable).

To continue the assembly, the back cover 42 is drawn against the end sections of the cables 33-35. The separately formed, left front half end seal 53 is then bolted to the integrally formed, left rear half end seal 51, with the taped section 38 of

the cable 35 and the blank plug 37 clamped tightly between the left front and left rear half end seals. Similarly, the separately formed, right front half end seal 54 is bolted to the integrally formed, right rear half end seal 52, with the taped sections 38 of the cables 34, 35 clamped tightly between the right front and right rear half end seals. The composite sealant wrapped around the sizing tape is pressed into the inner circumferential sealing grooves 67, 68 to form a tight seal between the cables 33-35 and the left and right end seals.

As shown in Figs. 3-6, 8, 9 and 13, the integrally formed, left rear and right rear half end seals 51, 52 are provided with locator pins 67' for reception in the corresponding apertures 68' in the separately formed, left front and right front half end seals 53, 54 to facilitate the alignment of the left and right half end seals 51-54.

The composite sealant is also disposed in the longitudinal sealing grooves 63 in the top and bottom flanges 43, 44 in the back cover 41 and in the outer circumferential sealing grooves 65 in the separately formed, left front and right front half end seals 53, 54, with the adhesive contacting and adhering to the longitudinal and circumferential sealing grooves and the sealant facing away from the grooves. When the front cover 42 is bolted into place over the back cover/spliced cables/end seal assembly, the composite sealant is pressed into the longitudinal sealing grooves 64 in the top and bottom flanges 45, 46 of the front cover and into the inner circumferential sealing grooves 66 of the front cover to securely seal the joint between the adjacent flanges 43, 45 and 44, 46 of the two covers 41, 42 and the joint between the left front and right front half end seals 53, 54 and the front cover.

When the front cover 42 is removed for access to the splice 36 (which is frequent in the telecommunications work), there is no disturbance to the splice or to the cables 33-35. The cables 33-35 remain firmly clamped (and undisturbed) between the end seals 51-54 while the repair or inspection work is being done on the splice 36 or the cables 33-35. This negates the need to use struts or tie bars between the end plates, as is necessary in other commonly used splice closures, to keep the end plates separated while the repair or inspection work is being carried out. The splice 36 is thus protected from the lateral tensile, as well as the vertical shear forces during any repair or inspection operation. Upon completion of the work, the front cover 42 is merely re-bolted into place over the back cover/spliced cables/end seal assembly.

As shown in Figs. 6, 7 and 10, the longitudinal sealing grooves 63, 64 in the flanges 43-46 of the back and front covers 41, 42 (in which a strip of composite sealant is placed) are provided with a waveform configuration - high in the region closest to the apertures 48 (in which the nut/bolt combinations 47 are received to attach the two covers 41, 42) and low in the region between the successive openings. The waveform configuration of these grooves 63, 64 compensates for the difference in pressure as the bolts 47 are tightened, so as to achieve more uniform pressure on the sealant along the grooves and to avoid any leaks.

The front and back covers 41, 42 and the two end seals 53, 54 are made from high strength polypropylene. However, any suitable high strength plastic or stainless steel may be used for the covers or the end seals.

One particular model of the splice closure 30 has the following dimensions: The overall length of the splice closure 30 is about 36 inches (about 91.5 cm). The outside diameter of the splice closure 30 is about 12 inches (about 30.5 cm) . The outside diameter of the left and right front half end seals is about 9.6 inches (about 24.4 cm). The center-to-center spacing between the two semicircular cavities 61, 62 in the end seals 51-54 is about 4.4 inches (about 11.2 cm). The diameter of the two semicircular cavities 61, 62 in the end seals 51-54 is about 4 inches (about 10.2 cm). The radius of the sealing grooves 63-66 is about 0.15 inch (about 0.4 cm). The radius of the inner circumferential sealing grooves 67, 68 in the end seals 51-54 is about 0.3 inch (about 0.8 cm). The center-to-center spacing between the apertures 48 in the longitudinal flanges 43-46 is about 4.625 inches (about 11.8 cm).

As shown in Fig. 2, the front cover 42 has two molded-in places 69 to retain a set of spare fasteners for use in the field. The spare fasteners can be supplied with the splice closure 30 from the factory. Also, the back and front covers 41, 42 are each equipped with four molded-in blank sections 70 for later openings. These blank sections 70 can be subsequently used for either air-pressure entries into the splice closure 30 or for pouring a setting-type polyurethane compound into the splice enclosure. The polyurethane compound is a commonly used sealant in the telecommunications industry.

As shown in Figs. 3-6, 9, 13 and 15, each of the molded half end seals 51-54 is provided with coring holes 71 to achieve uniform wall thickness in order to minimize warping, sink marks etc., during cooling.

As can be seen from the foregoing description, the subject splice closure has fewer parts, relatively inexpensive to manufacture, easy to assemble and disassemble - especially in the field, has low maintenance and can be used and re-used.

Although the present invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of the present invention as described and as defined in the following claims.

CLAIMS

1. A splice closure apparatus comprising:

a tubular protective case having a longitudinal axis and comprising first and second half tubular members, each of the half tubular members having a flange on each side thereof,

wherein the first and second ends of the first half tubular member are formed to define integrally therewith first and third half end seals, each of the integrally formed, first and third half end seals having a mating surface,

separately formed, second and fourth half end seals being configured to fit inside the first and second ends of the second half tubular member, each of the second and fourth half end seals having a mating surface,

means for sealingly securing the separately formed, second half end seal to the integrally formed, first half end seal such that the respective mating surfaces thereof define a longitudinal cable entrance at the first end of the protective case through which a first cable passes into the protective case,

means for sealingly securing the separately formed, fourth half end seal to the integrally formed, third half end seal such that the respective mating surfaces thereof define a longitudinal cable entrance at the second end of the protective case through which a second cable passes into the protective case to form a splice with the first cable, and

means for sealingly securing the adjacent flanges of the two half tubular members for forming the protective case for the splice.

2. The apparatus of claim 1 further including sealing material disposed between the respective flanges of the first and second half tubular members.

3. The apparatus of claim 2, wherein the sealing material is a composite comprising a substantially non-tacky, resilient and yieldable sealant non-releasably secured to an adhesive substrate.

4. The apparatus of claim 3, wherein the mating surface of each of the flanges of the first and second half tubular members is formed to include a longitudinal sealing groove, and wherein the sealing material is disposed in the longitudinal sealing grooves in the first half tubular member with the adhesive facing

and contacting the longitudinal sealing grooves and the non-tacky, resilient sealant facing and contacting the longitudinal sealing grooves in the second half tubular member.

5. The apparatus of claim 2, wherein the sealing material is a deformable mastic sealant.

6. The apparatus of claim 2, wherein the sealing material is a rubber-like gasket.

7. The apparatus of claim 1 further including sealing material disposed between the outer peripheral surfaces of the separately formed, second and fourth half end seals and the inner peripheral surfaces of the second half tubular member.

8. The apparatus of claim 7, wherein the sealing material is a composite comprising a substantially non-tacky, resilient and yieldable sealant non-releasably secured to an adhesive substrate.

9. The apparatus of claim 8, wherein each of the separately formed, second and fourth half end seals is formed to include a circumferential sealing groove around the outer peripheral surface thereof, wherein each end of the second half tubular member is formed to include a corresponding circumferential sealing groove around the inner peripheral surface thereof, and wherein the composite sealant is disposed in each of the outer circumferential sealing grooves in the second and fourth half end seals with the adhesive facing and contacting the outer circumferential sealing grooves and the non-tacky, resilient sealant facing and contacting the inner circumferential sealing grooves in the second half tubular member to form a seal between the outer peripheral surfaces of the second and fourth half end seals and the respective inner peripheral surfaces of the second half tubular member when the two half tubular members are joined together.

10. The apparatus of claim 1, wherein the mating surface of each of the flanges of the first and second half tubular members is formed to include a longitudinal sealing groove, wherein sealing material is disposed in the longitudinal sealing grooves between the respective flanges of the first and second half tubular members, wherein the means for securing the adjacent flanges of the two half tubular members comprises a plurality of spaced-apart fasteners disposed alongside the

longitudinal sealing grooves, and wherein each of the longitudinal sealing grooves is formed to have a wave-form longitudinal cross section such that it is shallower in the region between the successive fasteners and deeper in the region most adjacent to the fasteners.

11. The apparatus of claim 10, wherein the fasteners comprise a plurality of nut and bolt combinations.

12. The apparatus of claim 1, wherein the means for securing the separately formed, second half end seal to the integrally formed, first half end seal and for securing the separately formed, fourth half end seal to the integrally formed, third half end seal comprises nut and bolt combinations.

13. A splice closure apparatus comprising:

a tubular protective case having a longitudinal axis and comprising first and second half tubular members, each of the half tubular members having a flange on each side thereof,

the first end of the first half tubular member being formed to define a first semicircular end seal integrally therewith,

a separately formed, second semicircular end seal being configured to fit inside the first end of the second half tubular member,

each of the first and second semicircular end seals having a mating surface, means for sealingly securing the separately formed, second semicircular end seal to the integrally formed, first semicircular end seal such that the respective mating surfaces thereof define a longitudinal cable entrance therein through which a first cable passes into the protective case to form a splice when the first and second end seals are joined together, and

means for sealingly securing the adjacent flanges of the two half tubular members to define the protective case.

14. The apparatus of claim 13, wherein the second end of the first half tubular member is formed to define a third semicircular end seal integrally therewith, the apparatus including a separately formed, fourth semicircular end seal formed to fit inside the second end of the second half tubular member, each of the third and fourth semicircular end seals having a mating surface, the apparatus further

including means for sealingly securing the separately formed, fourth semicircular end seal to the integrally formed, third semicircular end seal such that the respective mating surfaces thereof define a longitudinal cable entrance therein through which a second cable passes into the protective case to form a splice with the first cable when the third and fourth end seals are joined together.

15. A splice closure apparatus comprising:

a tubular protective case having a longitudinal axis and comprising first and second half tubular members, each of the half tubular members having a flange on each side thereof,

the first end of the first half tubular member being formed to define a first half end seal integrally therewith,

a separately formed, second half end seal being formed to fit inside the first end of the second half tubular member,

each of the first and second half end seals having a mating surface,

means for sealingly securing the separately formed, second half end seal to the integrally formed, first half end seal such that the respective mating surfaces thereof define a longitudinal cable entrance at the first end of the protective case through which a first cable passes into the protective case to form a splice when the first and second end seals are joined together, and

means for sealingly securing the adjacent flanges of the two half tubular members to define the protective case for the splice.

16. The splice closure apparatus of claim 15, wherein the second end of the first half tubular member is formed to define a third half end seal integrally therewith, the apparatus including a separately formed, fourth half end seal formed to fit inside the second end of the second half tubular member, each of the third and fourth half end seal having a mating surface, the apparatus further including means for sealingly securing the separately formed, fourth half end seal to the integrally formed, third half end seal such that the respective mating surfaces thereof define a longitudinal cable entrance at the second end of the protective case through which a second cable passes into the protective case to form a splice with the first cable when the third and fourth end seals are joined together.

17. A process for making a combination of first and second cables forming a cable splice and a splice closure for the cable splice, the process comprising:

forming a tubular protective case comprising first and second half tubular members,

forming the first half tubular member to have a flange on each side identified as a first flange and as a third flange,

forming the second half tubular member to have a flange on each side identified as a second flange and a fourth flange,

forming the first and second ends of the first half tubular member to define integrally therewith first and third half end seals,

separately forming second and fourth half end seals to fit inside the first and second ends of the second half tubular member,

forming each half end seal to have a mating surface such that when the first and second half end seals are juxtaposed, the mating surfaces thereof define a first longitudinal cable entrance through which a first cable passes into the protective case, and such that when the third and fourth half end seals are juxtaposed, the mating surfaces thereof define a second longitudinal cable entrance through which a second cable passes into the protective case,

uniting the first and second half end seals with the first cable passing through the first longitudinal cable entrance and clamped between the mating surfaces thereof,

uniting the third and fourth half end seals with the second cable passing through the second longitudinal cable entrance and clamped between the mating surfaces thereof for forming a splice with the first cable,

uniting the first and second flanges, and

uniting the third and fourth flanges.

18. The process of claim 17 further including the following steps prior to the steps of uniting the first and second flanges and uniting the third and fourth flanges:

selecting a sealant,

positioning the sealant between the first flange and the second flange,

positioning the sealant between the third flange and the fourth flange, and

positioning the sealant between the outer peripheral surfaces of the separately formed, second and fourth half end seals and the corresponding interior surfaces of the second half tubular member.

19. The process of claim 18, wherein the step of selecting a sealant comprises forming a composite comprising a substantially non-adhesive, resilient and yieldable sealant non-releasably secured to an adhesive substrate.

20. The process of claim 19 wherein the step of positioning the sealant between the first flange and the second flange comprises:

positioning the composite between the first flange and the second flange with the adhesive substrate contacting and adhering to the first flange and with the substantially non-adhesive sealant contacting the second flange for ease of separation of the first flange from the second flange.

21. The process of claim 20 wherein the step of positioning the sealant between the third flange and the fourth flange comprises:

positioning the composite between the third flange the fourth flange with the adhesive contacting and adhering to the third flange and with the substantially non-adhesive sealant contacting the fourth flange for ease of separation of the third flange from the fourth flange.

22. The process of claim 21 wherein the step of positioning the sealant between the outer peripheral surfaces of the separately formed, second and fourth half end seals and the interior surfaces of the second half tubular member comprises:

positioning the composite between the outer peripheral surfaces of the separately formed, second and fourth half end seals and the corresponding inner peripheral surfaces of the second half tubular member with the adhesive contacting and adhering to the outer peripheral surfaces of the second and fourth end seals and with the substantially non-adhesive sealant contacting the interior surfaces of the second half tubular member for ease of separation of the second half tubular member from the second and fourth half end seals to expose the splice between the two cables.

23. The process of claim 22 further comprising the step of wrapping the end sections of the first and second cables with a sizing tape prior to the steps of uniting the first and second half end seals and uniting the third and fourth half end seals so that the cross sections of the wrapped cables are larger than the cross sections of the respective cable entrances.

24. The process of claim 23 further including the step of wrapping the end sections of the first and second cables with a strip of soft and sticky sealing material prior to the step of wrapping the end sections of the first and second cables with a sizing tape.

25. The process of claim 24 further including the step of placing the composite around the outermost wrap of the sizing tape prior to the steps of uniting the first and second half end seals and uniting the third and fourth half end seals, with the adhesive substrate contacting and adhering to the sizing tape and with the substantially non-adhesive sealant contacting the mating surfaces of the half end seals.

26. The process of claim 23 further comprising the step of selecting the sizing tape to be weather-proof and solvent-proof.

27. The process of claim 26 further comprising the step of selecting the sizing tape to have a high-friction surface.

28. The process of claim 27 further comprising the step of selecting the sizing tape to have on one side thereof a coating of sticky substance.

29. The process of claim 28 wherein the step of selecting the sizing tape to have on one side thereof a coating of sticky substance comprises the step of providing the said one side of the sizing tape with spaced-apart narrow strips of sticky substance.

30. A process for making a combination of first and second cables forming a cable splice and a splice closure for the cable splice, the process comprising:

forming a tubular protective case comprising first and second half tubular members,

forming the first half tubular member to have a flange on each side identified as a first flange and as a third flange,

forming the second half tubular member to have a flange on each side identified as a second flange and a fourth flange,

forming the first and second ends of the first half tubular member to define integrally therewith first and third half end seals,

separately forming second and fourth half end seals to fit inside the first and second ends of the second half tubular member,

forming each end seal to have a mating surface such that when the first and second half end seals are positioned in a mating relationship, the mating surfaces thereof define a first longitudinal cable entrance through which a first cable passes into the protective case, and such that when the third and fourth half end seals are positioned in a mating relationship, the mating surfaces thereof define a second longitudinal cable entrance through which a second cable passes into the protective case,

uniting the first and second half end seals with the first cable passing through the first longitudinal cable entrance and clamped between the mating surfaces thereof,

uniting the third and fourth half end seals with the second cable passing through the second longitudinal cable entrance and clamped between the mating surfaces thereof for forming a splice with the first cable,

forming a composite comprising a substantially non-adhesive, resilient and yieldable sealant non-releasably secured to an adhesive,

positioning the composite between the first flange and the second flange with the adhesive contacting and adhering to the first flange and with the substantially non-adhesive sealant contacting the second flange for ease of separation of the first flange from the second flange,

positioning the composite between the third flange the fourth flange with the adhesive contacting and adhering to the third flange and with the substantially non-adhesive sealant contacting the fourth flange for ease of separation of the third flange from the fourth flange;

positioning the composite between the outer peripheral surfaces of the separately formed, second and fourth half end seals and the inner surfaces of the second half tubular member with the adhesive contacting and adhering to the outer peripheral surfaces of the second and fourth half end seals and with the substantially non-adhesive sealant contacting the inner peripheral surfaces of the second half tubular

member for ease of separation of the second half tubular member from the second and fourth half end seals,

uniting the first and second flanges, and

uniting the third and fourth flanges.

31. The process of claim 30 further comprising the steps of:

forming longitudinal sealing grooves in the respective mating surfaces of the flanges of the first and second half tubular members, and

disposing the composite in the longitudinal sealing grooves of the first and third flanges of the first half tubular members with the adhesive contacting and adhering to the longitudinal sealing grooves and the sealant contacting the second and fourth flanges of the second half tubular member.

32. The process of claim 31 further comprising the steps of:

using a plurality of fasteners alongside of the longitudinal sealing grooves for uniting the first and second flanges and the third and fourth flanges respectively of the first and second half tubular members, and

forming the longitudinal sealing grooves having the composite disposed therein to have a wave-form longitudinal cross section to compensate for the pressure variation resulting from the use of the said plurality of fasteners .

33. The process of claim 32, wherein the step of using a plurality of fasteners comprises the step of using a plurality of nut and bolt combinations for securing the first and second half tubular members.

34. The process of claim 31 further comprising the steps of:

forming circumferential sealing grooves around the outer peripheral surfaces of the second and fourth half end seals, and

disposing the composite in the outer circumferential sealing grooves of the separately formed, second and fourth half end seals with the adhesive contacting and adhering to the circumferential sealing grooves and the sealant contacting the corresponding inner peripheral surfaces of the second half tubular member.

35. The process of claim 34 further comprising the step of wrapping the end sections of the first and second cables with a sizing tape prior to the steps of uniting the first and second half end seals and uniting the third and fourth half end seals

so that the cross sections of the wrapped cables are larger than the cross sections of the respective cable entrances.

36. The process of claim 35 further including the step of wrapping the end sections of the first and second cables with a strip of soft and sticky sealing material prior to the step of wrapping the end sections of the first and second cables with a sizing tape.

37. The process of claim 36 further including the step of placing the composite around the outermost wrap of the sizing tape prior to the steps of uniting the first and second half end seals and uniting the third and fourth half end seals, with the adhesive substrate contacting and adhering to the sizing tape and with the substantially non-adhesive sealant contacting the mating surfaces of the half end seals.

38. The process of claim 35 further comprising the step of selecting the sizing tape to be weather-proof and solvent-proof.

39. The process of claim 38 further comprising the step of selecting the sizing tape to have a high friction surface.

40. The process of claim 39 further comprising the step of selecting the sizing tape to have on one side thereof a coating of sticky substance.

41. The process of claim 40 wherein the step of selecting the sizing tape to have on one side thereof a coating of sticky substance comprises the step of providing the said one side of the sizing tape with spaced-apart narrow strips of sticky substance.

42. The process of claim 30, wherein the step of forming each end seal to have a mating surface comprises forming each end seal to have a mating surface such that when the first and second half end seals are positioned in a mating relationship, the mating surfaces thereof define a first set of two longitudinal cable entrances through which a first set of two cables pass into the protective case, and such that when the third and fourth half end seals are positioned in a mating relationship, the mating surfaces thereof define a second set of two longitudinal cable entrances through which a second set of two cables pass into the protective case.

43. The process of claim 30, wherein the step of forming each end seal to have a mating surface comprises forming each end seal to have a mating surface such that when the first and second half end seals are positioned in a mating

relationship, the mating surfaces thereof define a first set of three longitudinal cable entrances through which a first set of three cables pass into the protective case, and such that when the third and fourth half end seals are positioned in a mating relationship, the mating surfaces thereof define a second set of three longitudinal cable entrances through which a second set of three cables pass into the protective case.

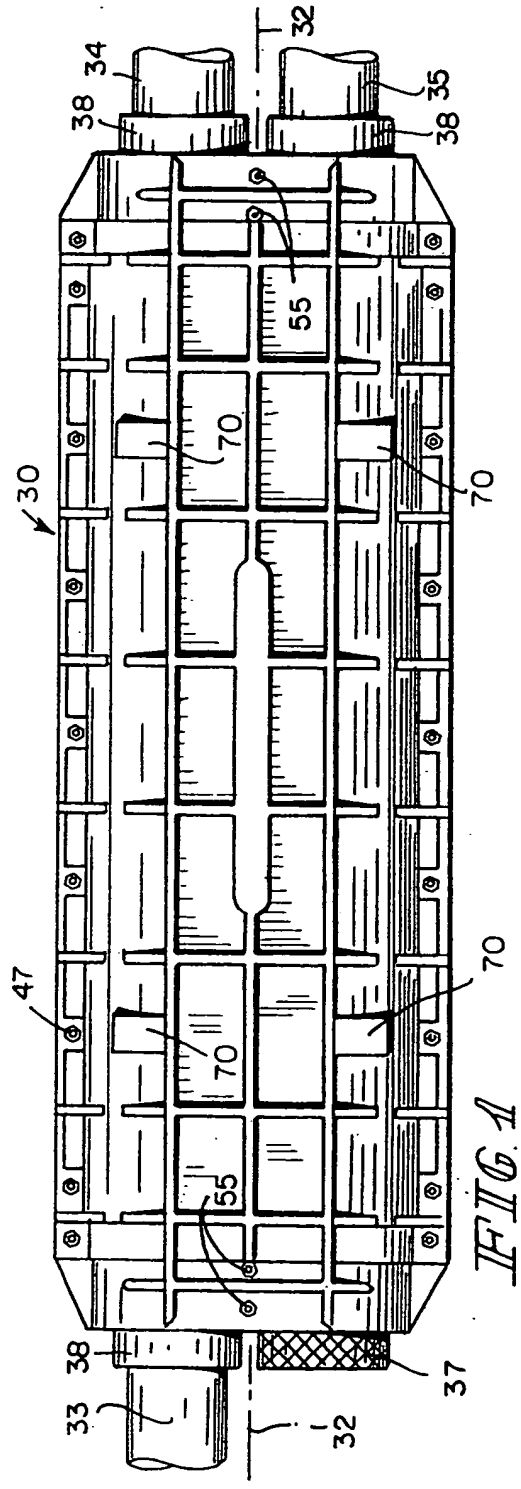

FIG. 1

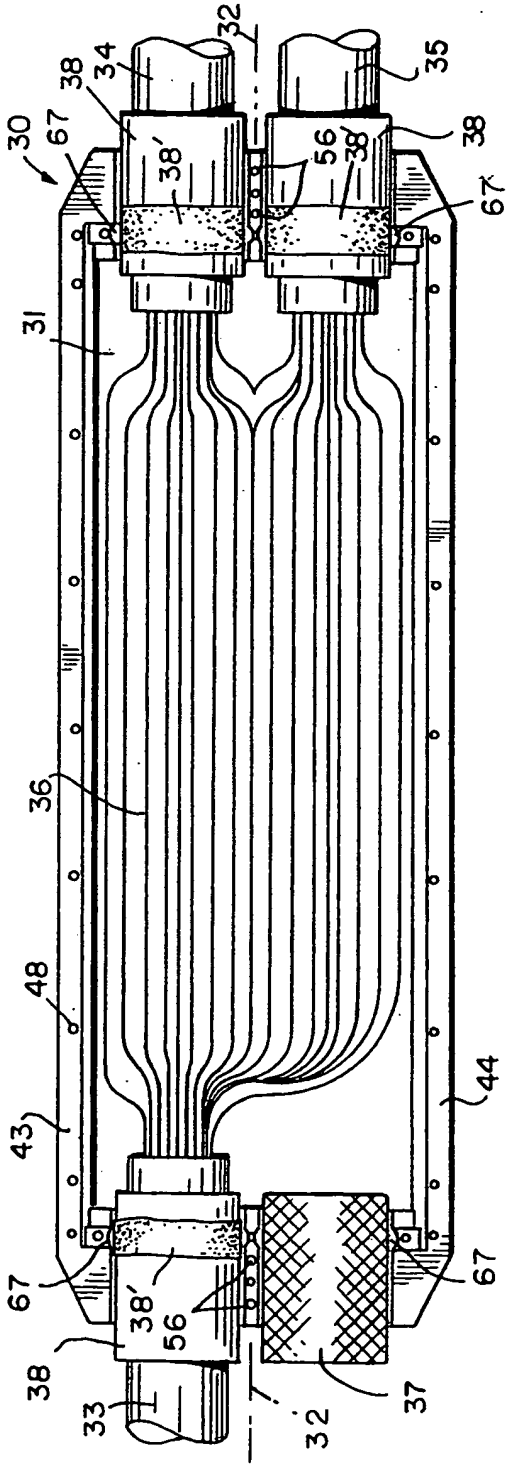

FIG. 2

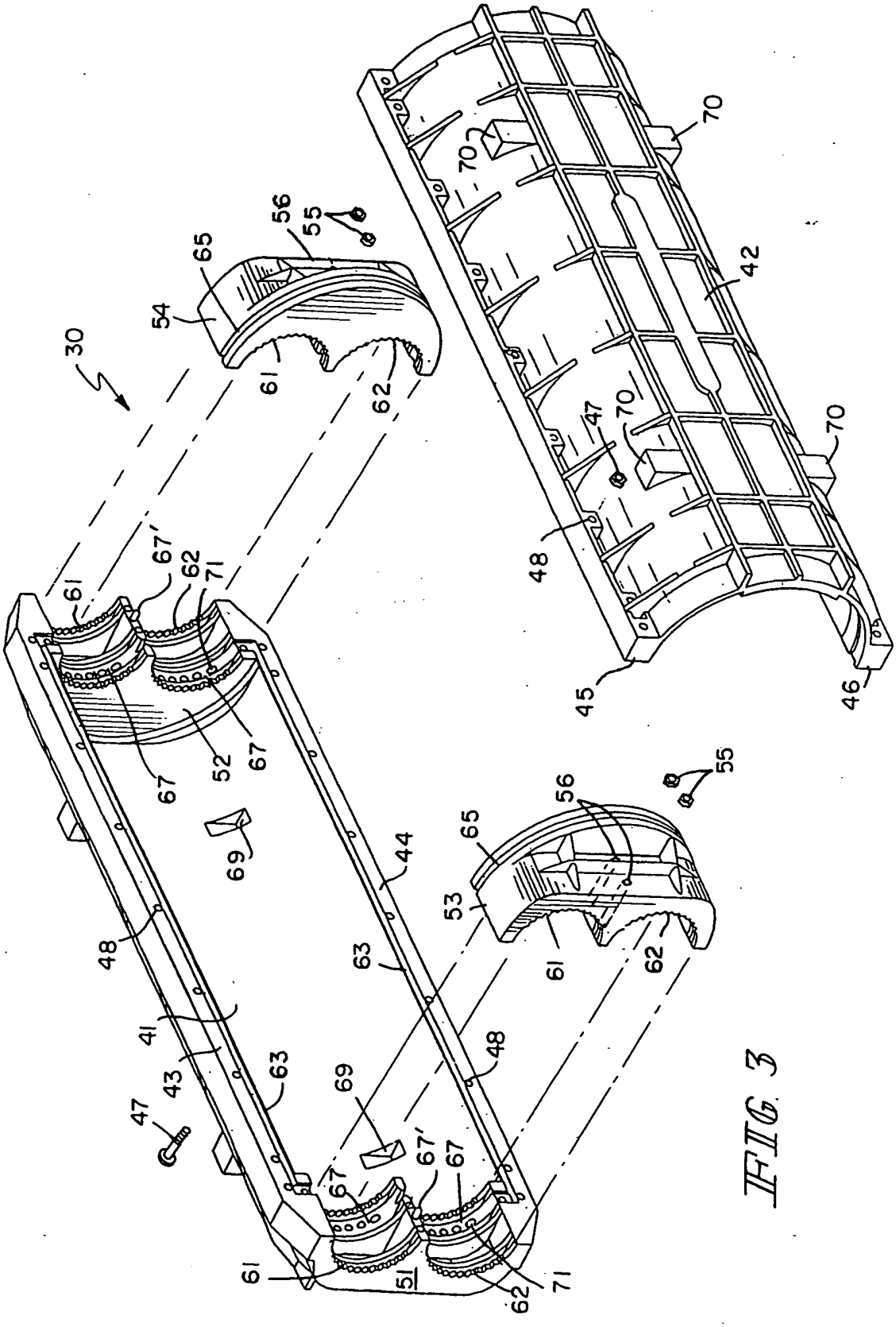

FIG 3

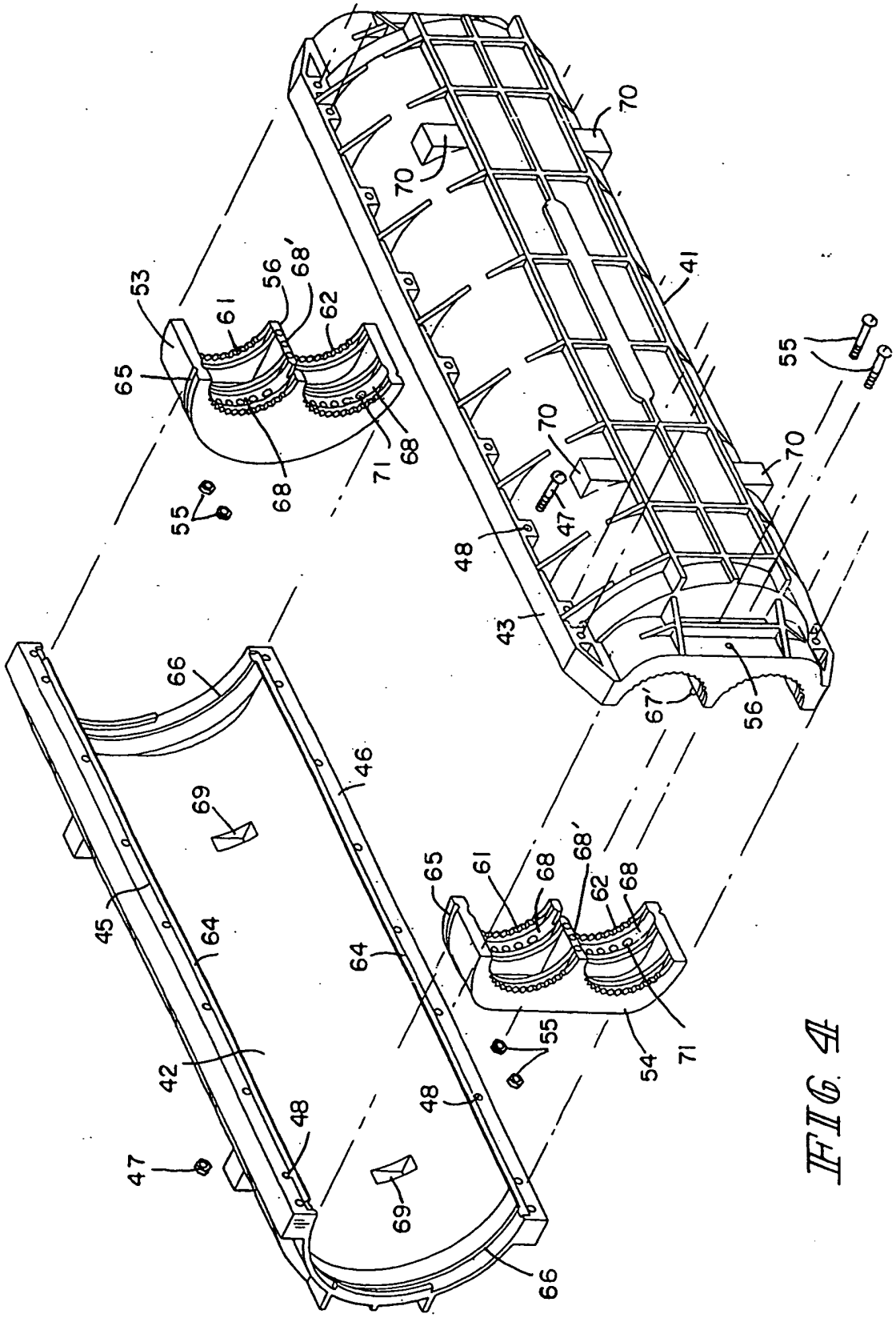
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FIG 4

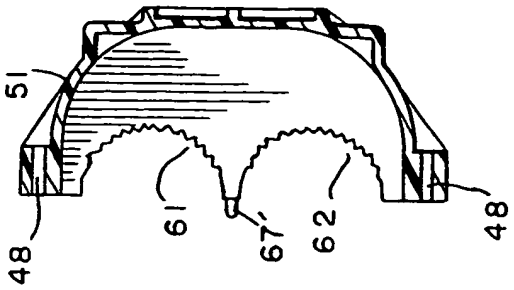

FIG. 8

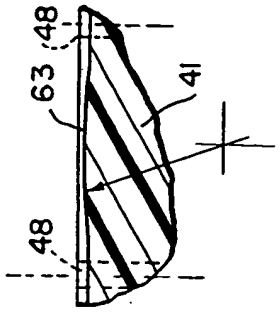

FIG. 7

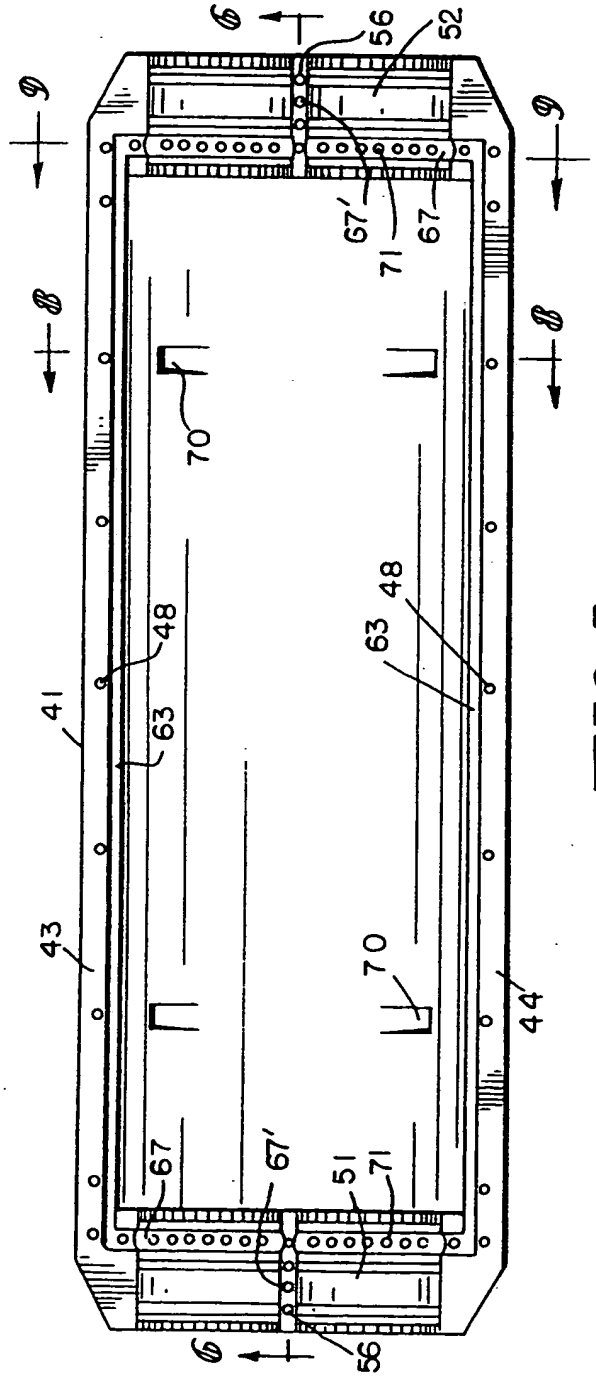

FIG. 5

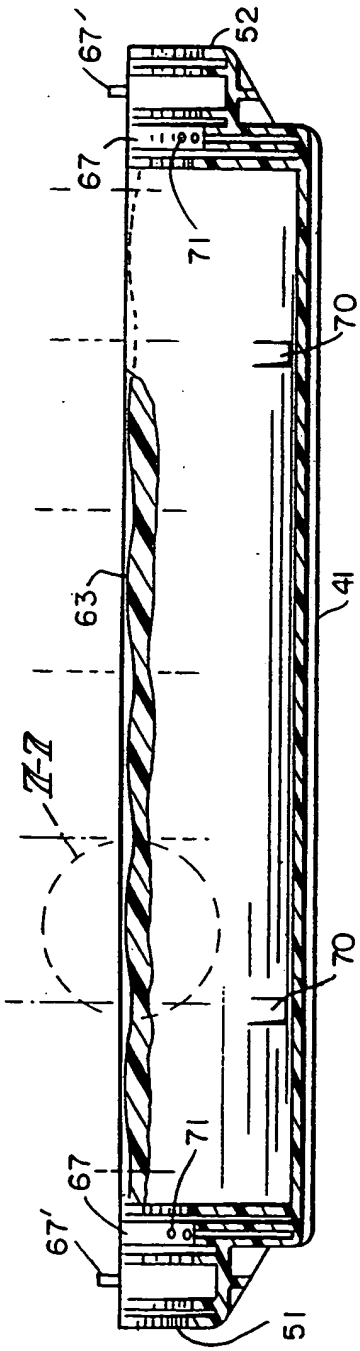

FIG. 6

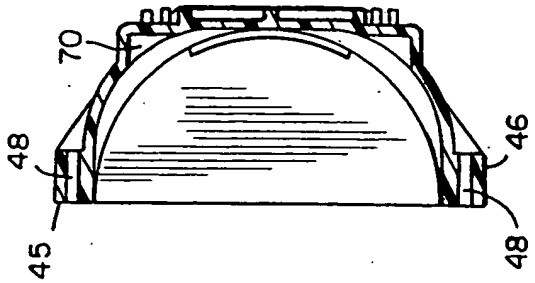

FIG. 12

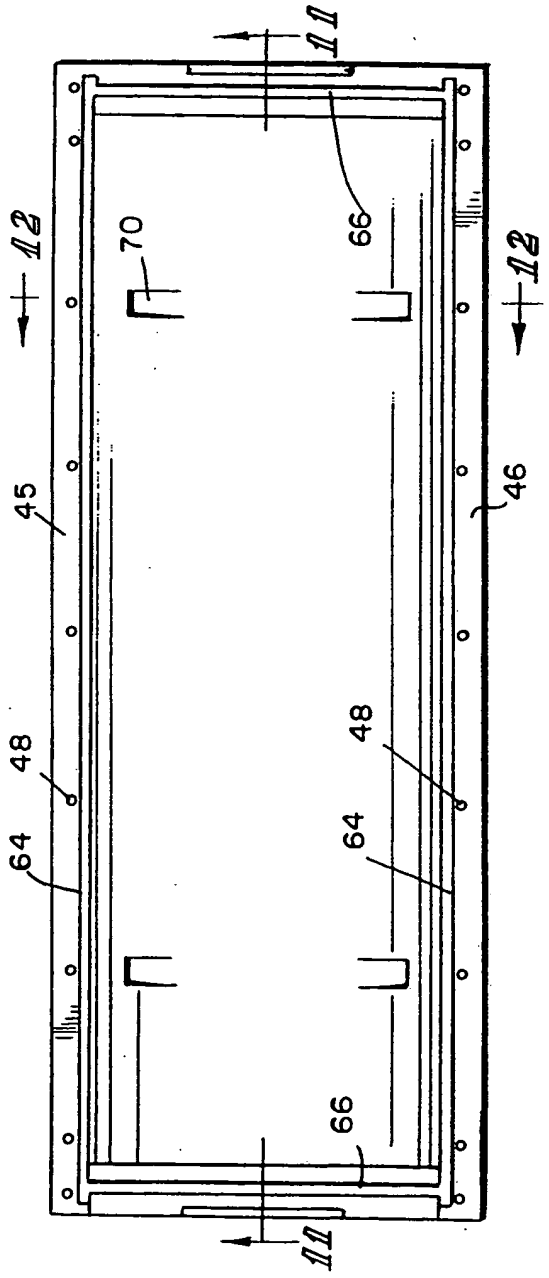

FIG. 10

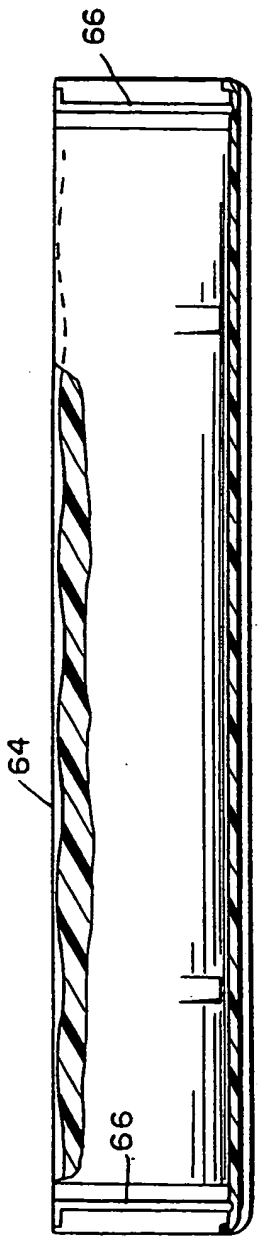

FIG. 11

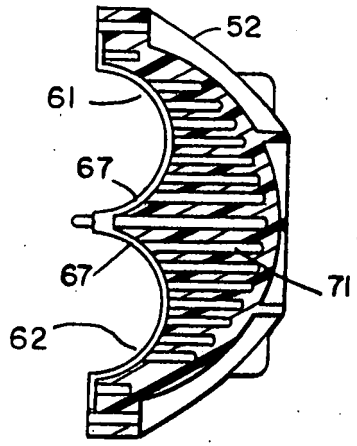

FIG. 9

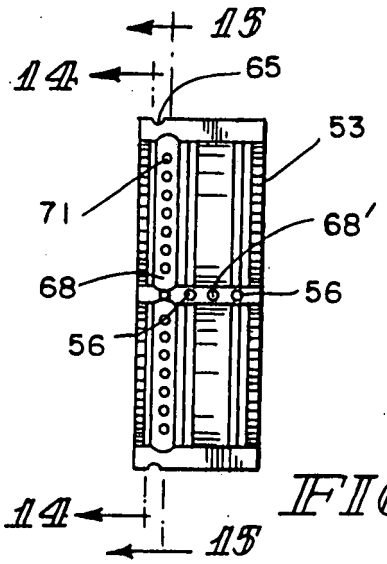

FIG. 13

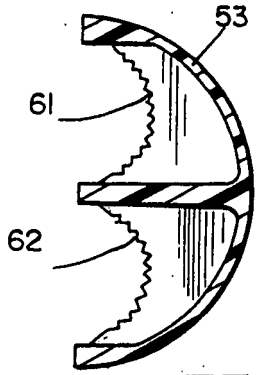

FIG. 14

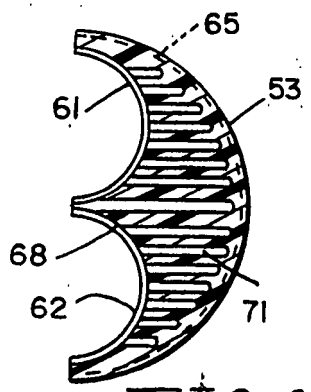

FIG. 15

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 99/14700

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02G15/013 H02G15/113

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 778 643 A (RXS SCHRUMPFTECH GARNITUREN) 11 June 1997 see column 3, line 15 - line 19; claims 23,24; figure 1	1,13,15, 17,30
A	US 4 117 259 A (GIEBEL WOLFGANG ET AL) 26 September 1978 see column 1, line 51 - line 56 see column 3, line 57 - column 68 see figure 4	1,13,15, 17,30

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 October 1999	12/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Moueza, A

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INTERNATIONAL SEARCH REPORT

ormation on patent family members

Interr nal Application No
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